FOREWORD

The PSWN Program Management Office commissioned Booz·Allen & Hamilton, Inc., a worldwide management and technology consulting firm, to conduct an independent study of public safety communications in the spectrum located around the 800 MHz band. This report assesses the relative merits of 800 MHz as an operating frequency band for public safety wireless communications, and the extent to which 800 MHz operations have affected interoperability among systems at all levels of government. The report is intended to serve as a catalyst for future discussions regarding the use of 800 MHz spectrum by the public safety community.

The findings contained in the 800MHz Study final report are aggregates of three primary sources of information. The first source is detailed analyses of filings to the Federal Communications Commission (FCC), including each of the 55 National Public Safety Planning Advisory Committee regional plans and subsequent docket histories. The second includes an initial technical analysis of radio frequency propagation characteristics. The third is a set of interviews conducted with several members of the public safety community. Specifically, the publicly available regional plans and docket histories were analyzed using a matrix that compared each of the plans across equivalent categories. Questions based on trends and hypotheses were developed during the analysis of FCC documentation. The trends and hypotheses were then further explored using the interview process. Together, the data contained in the matrix and gathered through the interview process serve as the basis for the final report.

To make comments regarding the information contained in this document, please contact Mr. Dave Williams, Booz·Allen & Hamilton, at 8283 Greensboro Drive, McLean, Virginia, 22102-3838, or by faxing comments to (703) 279-2035.

EXECUTIVE SUMMARY

The Public Safety Wireless Network (PSWN) program commissioned the consulting firm, Booz·Allen & Hamilton Inc. (BAH), to perform an independent study of the relative benefits and shortcomings of public safety land mobile radio (LMR) systems operating in the 800-Megahertz (MHz) frequency band. Public safety has been assigned frequencies in the 806-821/851-866 MHz and 821-824/866-869 MHz portions of the 800 MHz band. For the purposes of this study, these portions will be generically referred to as the 800 MHz band. Since the early 1980s, the Federal Communications Commission (FCC) has assigned approximately 300 channels located in the 800 MHz spectrum band for use by state and local public safety entities. The FCC has allocated 24 MHz of additional spectrum, in or near the 800 MHz band for public safety use and is currently engaged in establishing service rules for this spectrum. Given the availability of 800 MHz channels and the lack of additional spectrum resources at lower frequencies, many states, counties, and municipalities have installed or at least considered implementing 800 MHz systems. Unfortunately, the basis for public safety operation in this frequency range and the associated effect on interoperability has not been formally established. In addition, the costs and operational changes associated with 800 MHz systems have not been systematically assessed.

To increase general understanding and to begin to assess the relative merits of 800 MHz as an operating frequency band for public safety wireless communications, research and analysis was completed in three study areas. First, and primarily, the effectiveness of the two processes used to manage and administer 800 MHz spectrum to the public safety community was compared, contrasted, and assessed. Second, 800 MHz signal propagation was compared with propagation characteristics of other public safety bands. Last, BAH compiled technical and operational perspectives of several public safety officials who plan, administer, or use public safety radio systems.

Over the past thirty years, the FCC has provided two separate frequency allocations around 800 MHz for public safety use. The first of these allocations occurred in the early 1970s and involved the so-called "general service channels." The second of these allocations occurred in the 1980s in response to existing problems with interoperable communications among local, state, and federal public safety agencies. Each of these allocations was administered and managed by processes based on different regulatory philosophies.

The planning and management process used to assign and administer the general service channels located within the 806-821/851-866 MHz band allowed system administrators and engineers a great deal of flexibility to implement new 800 MHz systems for public safety use. The built-in flexibility encouraged LMR vendors to develop systems that used, and advanced the development of, emerging wireless communications technologies. Unfortunately, the flexibility within the general service channel process also led to a lack of system standardization and the proliferation of a variety of incompatible systems. Despite the involvement of the public safety community at the onset of the process, no vehicle was developed for coordination among separate public safety entities during the assignment and system development phases of the

process. The FCC and the public safety community recognized that future spectrum allocation processes should more actively involve the public safety community and contain provisions that encourage the use of spectrally efficient technologies.

In 1987, the FCC, working cooperatively with the public safety community[1], adopted the National Public Safety Plan—a more explicit and controlled process for assigning and administering an additional 6 MHz of spectrum in the 800 MHz band for use by the public safety community. The National Plan, as it is commonly called, provided the planning and management process for the assignment of frequencies within the 821-824/866-869 MHz bands. The FCC created the National Plan to specifically accomplish two goals: encourage efficient use of the spectrum, and increase interoperability among communications systems, thereby enabling local, state, and federal public safety agencies to better coordinate their activities.

To achieve these goals, the National Plan divided the Nation into 55 regions and called for the formation of regional planning committees (RPC), each consisting of members of the public safety community. The RPCs were chartered to describe how the 821-824/866-869 MHz bands would be efficiently used within their respective regions and also how intra- and inter-regional interoperability would be achieved or improved. The RPCs elected chairpersons and were encouraged to establish balanced membership with representation from multiple public safety entities within their respective regions. In reality, many of these committees have large contingents of law enforcement agencies from large metropolitan areas. Small public safety agencies consisting of less than 25 members usually lacked representation. The limited participation by the smaller public safety agencies may be due in large part to the lack of available funding to underwrite participation in the committees. Participation on the committees is voluntary and, in general, the costs are borne by the participant or the participant's agency.

Each of the 55 regional committees completed their respective plans within the five years allotted for the process. Some regions with dire spectrum needs or immediate plans to implement new 800 MHz systems expedited the completion of their plans; the earliest plan was approved nine months after the spectrum became available. Other regions were more deliberate, taking the full five years to submit a plan for approval. A significant number of the regional planning committees used a common template to create their regional plans. The templates simplified the plan development process and standardized its contents. Notwithstanding these positive effects, it is likely that the standard template may have stifled some creativity that could have further improved intra- and inter-regional interoperability.

The National Plan also created mutual aid channels to be used to facilitate interoperability among local, state, and federal public safety agencies. For a number of reasons, these channels have been largely ineffective at improving interoperability on any large scale. Many public safety entities operate in lower frequency bands, especially federal agencies, and communications on the NPSPAC mutual aid channels for these entities is difficult. Federal public safety agencies, for example, cannot license channels in the 800 MHz range. In order to use 800 MHz channels, federal agencies must be granted permission by the state or local entity licensed on those channels. No such agreements are necessary among local, state, and federal

[1] The FCC sponsored direct involvement of the public safety community through a newly established body called the National Public Safety Planning Advisory Committee (NPSPAC)

agencies for use of the NPSPAC mutual aid channels. However, several public safety officials who were questioned indicated that the mutual aid channels on their systems were largely unused. Despite this, few believe the concept of mutual-aid interoperability channels should be abandoned; to be effective, such channels should be identified in the multiple bands used by public safety. Also each public safety entity, whether local, state, and federal, should have equal licensing and usage rights on the interoperability spectrum.

The National Plan required that each regional plan be reviewed and signed by each of the adjacent regions in an effort to promote inter-regional coordination and ultimately improve inter-regional interoperability. While conceptually a good idea, this inter-regional vetting of plans was actually little more than a "rubber-stamp" process en route to regional plan approval. Inter-regional coordination and interoperability planning could have benefited from an effective oversight body that could assist in regional plan development and intervene in inter-regional disputes.

As part of the study, BAH was asked to assess, "Is 800 MHz truly right for public safety?" In comparing 800 MHz signal propagation with other frequency bands typically used by the public safety community, it is concluded that 800 MHz is not universally better or worse than other portions of the spectrum. Many states, counties, and municipalities are replacing aging public safety radio systems with new systems operating in the 800 MHz band. These groups have accurately identified benefits to migrating to the 800 MHz band. The lack of available spectrum in the lower frequency bands and the availability of 800 MHz channels have served as drivers for system planners to migrate to 800 MHz systems. Metropolitan users have, in some cases, achieved better coverage with an 800 MHz system as compared to the older VHF systems. This improvement in coverage may be due in part to the addition of new tower sites throughout the metropolitan area. The implementation of new infrastructure has allowed system planners to better plan and design new radio systems. These enhanced planning and design processes provide system users the possible perception of greater reliability.

Although spectrum is presently available in the 800 MHz band, some systems planners are choosing to build new systems using the lower frequency bands. Two of the deciding factors are coverage and system costs. Larger systems, in terms of coverage area, generally operate at lower frequencies, because an inverse relationship exists between frequency and range— as frequency increases, range decreases. Perhaps the most significant factor is cost. Since the range of lower frequency systems is greater, greater coverage area can generally be achieved with less equipment infrastructure.

An issue that system planners have had to consider is the proliferation of incompatible 800 MHz trunked systems. The lack of a trunking standard, which would allow for open architectures in radio systems, has led to the development of incompatible 800 MHz systems built by different vendors. The proliferation of these incompatible systems has impeded the improvement of inter-jurisdictional interoperability. Each major LMR vendor has its own signal processing scheme for implementing trunked networks. The differences among these schemes are a serious impediment to seamless communications among disparate vendor systems.

In summary, 800 MHz is in fact "… right for public safety," as is VHF and low-band UHF. LMR system planners, engineers, and users are thoroughly measuring the pros and cons of systems operating in each of these bands against their unique communications needs. They are assessing critical factors such as, spectrum availability, coverage within their environment, interoperability with neighboring systems, and cost. The percentage or number of new 800 MHz systems determined to be superior for public safety use within an area when compared to other systems in public safety bands is not yet known. It is certain, however, that an 800 MHz system "makes sense" in some situations, while a VHF or UHF system would be more efficient and cost-effective in other areas. The challenge for the public safety community is to obtain or maintain sufficient spectrum in each of the bands and create workable interoperability plans that fully integrate spectrum, systems, and system users into an interoperable, nationwide communications network.

ACKNOWLEDGEMENTS

The PSWN PMO wishes to thank the individuals who contributed to this 800 MHz Study. The individuals listed below provided valuable information by participating in the interviews, submitting written thoughts, and providing general input to guide the direction of the study and subsequent report.

The opinions expressed by the interview participants do not necessarily represent the views of the departments and agencies from which they are employed.

Name	Title
2nd Lieutenant Curt J. Andrich	Radio Services Manager, Fairfax County, Virginia Police Department
Don Appleby	Project Director, Office of Administration for the State of Pennsylvania
Lieutenant Barry Barnard	Program Manager, Prince William County, Virginia Police Department
John Biggity	Radio Manager, Prince George's County, Maryland
Sergeant Bruce Blair	Radio Systems Manager, Technology Division-Montgomery County, Maryland Police Department
Mike Borrego	Acting Director, Communications Services Group-Division of Colorado Information Technology Services-Department of General Administration
Joe Bruno	City Communications Office, Mesa, Arizona
Mark Cournoyer	Commander of Technical Services, Alexandria, Virginia Police Department
Tim Dunn	Deputy Manager of Public Safety, City and County of Denver, Colorado
Dennis Ellwell	Supervising Telecommunications Engineer, Department of General Services, State of California Telecommunications Division
David T. Endicott	Battalion Chief, Prince William County, Virginia Department of Fire and Rescue
Jack Forsythe	Director, Public Safety Communications for Prince George's County, Maryland
Mohammed Ghani	Technical Systems, Specialist Arvada, Colorado Police Department
Ron Haraseth	Telecommunications System Analyst, State of Montana Information Service Division
Dean Hart	Technical Systems Manager, Kansas City, Missouri Police Department
Kevin Kearns	Manager, King County, Washington Emergency Management Division
Lieutenant Thomas Kraft	Strongsville, Ohio Police Department

Name	Title
Steve Marzolf	Technical Manager, Prince William County, Virginia Public Safety Communications
Lieutenant Steve Mason	Commander of Communications, Alexandria, Virginia Police Department
Ron Mayworm	Wireless Systems Coordinator, City of College Station, Texas
Lee Minert	Special Services for Iowa State Patrol, Iowa State Police Department
Joe Noce	Public Safety Communications Administrator, Mesa, Arizona Police Department
Jon Obradovich	Telecommunications Manager, State of Pennsylvania
Paul Pedersen	Director, Clackamas County, Oregon Communications Department
Don Pfohl	City Communications Office, Mesa, Arizona
Dwight Purtle	Technical System Manager, Johnson County, Kansas Emergency Communications for Fire/EMS
Doug Robinson	Director of Radio Communications, State of Alaska
Bob Schlieman	Radio Engineer, New York State Police Department
Captain Dick Schurman	Assistant Chief of Police, Joplin County, Missouri Police Department
Sam Somers	Communications Engineer, Office of Information Technology for Prince William County, Virginia
Steve Souder	Administrator, Arlington County, Virginia Emergency Communications Center
Gene Sowles	Public Works, Municipality of Anchorage, Alaska
Vincent Stile	Communications of Radio Systems Director, Suffolk County, New York Police Department
Frank Stoda	Radio Engineer, Fairfax County, Virginia Police Department
Jim Stoneback	Radio Engineer, Fairfax County, Virginia Police Department
Tom Struzzieri	Virginia State Police
Lisa Thompson	800 MHz Radio System Manager, Arlington County, Virginia Emergency Communications Center
Peter Ungar	Telecommunications Services Manager, City of Fort Worth, Texas
Lieutenant Jeff Weil	Communications Director, Kansas State Highway Patrol
J. Henry Williams	City Radio Manager, Alexandria, Virginia Police Department

TABLE OF CONTENTS

TABLE OF FIGURES

TABLE OF TABLES